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TROPIC ENVIRONMENTAL TEST OF MISSILE AND
ROCKET SYSTEMS

Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland

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13. ABSTRACT

Provides background information relative to test and evaluation of missile and rocket systems. Identifies supporting tests, facilities and equipment required. Discusses conduct of test, test data, and analysis procedures. Applicable to storage and field test in wet-warm and wet-hot climatic categories. Excludes simulated environments.

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Test Operations Procedure 5-1-032

**TROPIC ENVIRONMENTAL TEST
OF MISSILE AND ROCKET SYSTEMS**

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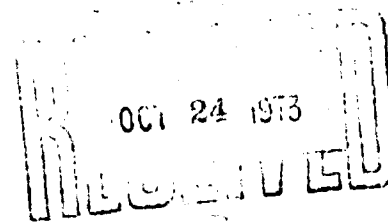
**SECTION I
GENERAL**

1. Purpose and Scope

a. Summary. This Test Operations Procedure provides a method of evaluating the capability of missile and rocket systems to function effectively during and after exposure to the wet-warm, wet-hot climatic categories (AR 70-38, reference 1). This document describes conditions and procedures to which the test item will be subjected for storage and field use testing in a humid tropic environment. These procedures apply to missile and rocket systems whether vehicle- or man-transportable. The procedures apply not only to the missile or rocket, but also to the launching facility, control system, fire distribution system, transport system, maintenance equipment, and auxiliary equipment. Standard subtests and objectives are listed below:

- (1) Initial inspection—Evaluate physical condition, completeness, and suitability for testing.
- (2) Initial performance—Establish initial performance to which after-storage performance can be compared.
- (3) Tropic storage—Determine the test item's capability to resist the detrimental effects of the tropic environment.

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(4) Tropic performance—Evaluate operational performance after storage and when employed under conditions encountered in a tropic environment.

(5) Maintenance evaluation—Evaluate maintenance characteristics and the suitability of the maintenance package under tropic environmental conditions.

(6) Human factors—Evaluate design and performance characteristics affecting the user, with primary emphasis on those areas peculiar to the humid tropic environment.

(7) Safety—Determine if the test item is safe for its intended use during and after storage in a humid tropic environment and confirm the safety release.

b. Limitations. This TOP covers storage and field use testing in the humid tropics with no instructions provided for simulated environments. Procedures are limited to missiles and rockets that require exposure to those environmental conditions described in AR 70-38, Section II, paragraphs 2-7 and 2-8. (The procedures set forth do not constitute a complete or detailed test plan.) A detailed test plan can be developed using the procedures of this TOP, the Test Directive, the Materiel Needs document, the commodity TOP or Materiel Test Procedure, and related references.

2. Basic Information

a. Background. New items developed and produced for the United States Army must perform satisfactorily in all of the world's environments. The warm temperature and high humidity of the tropics combine to produce heavy vegetation and a great variety of microorganisms, insects, and animals. All of these factors, separately or in combination, contribute to the deterioration of materiel. Therefore, testing in the tropic environment is required to evaluate performance under storage and field use conditions when the item is intended for use in the tropic environment. A more detailed discussion of tropic environmental effects is found in TOP 1-1-008 (reference 7).

b. Data should be obtained in sufficient quantity to support valid conclusions. These conclusions may be constrained by limited numbers of test or control items, by a limited time in which to accomplish testing, or by shortages of funds, manpower, or general support facilities. To identify the best means of securing meaningful data within the limitations imposed, the test officer should establish close liaison with available statistical and human factors personnel. The statistician can contribute to establishing the overall experimental pattern, recommending the number of test soldiers required, and advising on the number of repetitions required to obtain maximum results from specific operations. Human factors personnel may provide guidance in the development and presentation of questionnaires, interviews, and the human factors considerations of tests, plans, and reports. Further statistical guidance will be found in TOP 3-1-002, (reference 11).

c. Required Equipment and Facilities.

- (1) Secure storage area
- (2) Firing range
- (3) Portability/transportability area
- (4) Test equipment (event recorders, circuit testers, timers, rangefinders, etc.)
- (5) Targets
- (6) Still and motion picture, and video instrumentation systems
- (7) Special tools for inspection and/or repair of test item
- (8) Meteorological support

SECTION II TECHNICAL PRESENTATION

3. Preparation for Test.

a. Conduct a review of applicable requirements in the Materiel Needs document, review the guidance and objectives of the test directive, and study the test method and analytical plan of the test plan.

b. Based on the review and evaluation in paragraph a, above, determine whether the test plan requires changes. If revision is necessary, prepare a change notice in accordance with TECR 70-24 (reference 3).

c. Prepare a test officer's log book, data collection sheets, and personnel and support requests. Prepare a detailed test schedule and submit a request for range clearance.

d. Select test equipment and record nomenclature, serial numbers, accuracy, calibration requirements, date of last calibration, and date next calibration is required.

e. Review the safety release, applicable safety SOP and range regulations. Prepare or requisition adequate safety precautions/equipment for personnel and equipment (paragraph 4f, below).

f. Record the grade, MOS, background, and training of all test personnel. Insure that test personnel are properly trained and briefed on the test objectives, test item characteristics, safety precautions, and data collection techniques. Prepare, in concert

with the human factors engineer: questionnaires for structured interviews to evaluate the man-machine compatibility, and data sheets to record the required physiological and psychological background of test participants.

g. Insure that final arrangements are made with supporting or participating agencies, activities, or facilities.

h. Review results of testing previously conducted on test item in simulated environments related to the tropic environment, such as appropriate test specified in MIL-STD 810B (reference 6), temperature-humidity cycling, rain and salt spray, and fungus. These test data should provide indications of test item limitations or actual performance to be expected from the test item.

4. Test Conduct

a. Initial Inspection.

(1) Inspect the test item prior to unpacking, and/or prior to unloading and record the material, methods, and adequacy of crating, blocking, and tie-down provisions used (photograph as required).

(2) For each individually furnished component, record the following:

(a) Nomenclature

(b) Model designation

(c) Manufacturer

(d) Originating point of shipment

(e) Mode of shipment

(f) Level of packaging

(g) Damage to packaging (photograph as required)

(3) Inventory against the packing list all test items and equipment received. Record any missing or excess items.

(4) Remove packing, packaging, and preservation materials.

(5) Visually inspect all components for serviceability and any damage or defects (photograph as required).

(6) Correct any damage or defects in accordance with the applicable technical manual. If corrective action cannot be taken, remove the item from the test.

(7) Measure and record the following:

- (a) Dimensions (length, width, diameter, etc.)
- (b) Weights of test item, components, and accessories
- (c) Hour and/or mileage readings
- (d) Color (include presence of reflecting surfaces)

(8) Prepare the test item for testing. This will include all actions necessary to take the test item from an inspection status to an operational status. This will be accomplished using the applicable technical manuals.

b. Initial Performance.

(1) When test sample size and configuration permit, randomly select a representative sample of test items and subject them to functional testing using the procedure in paragraph d, below. This sample is used to establish initial performance and provides a basis for comparing subsequent test data.

(2) Poor performance may indicate damage or defects not detected during the initial inspection. Determining poor performance prior to placing the test item in storage can save considerable time and expense.

(3) This subtest will aid in evaluating the following:

- (a) Data collection methods
- (b) Instrumentation
- (c) Training of personnel
- (d) Adequacy of support equipment and facilities
- (e) Adequacy of documentation
- (f) Test item initial performance

c. Tropic Storage. Test item storage will be consistent with normal procedures for the type of item and its packaging. The storage configuration, i.e., field storage, covered, etc., will be based on the security, the Materiel Needs document, and requirements of AR 70-38, but will generally represent typical storage conditions. In all cases where the typical

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storage time can be identified and it is compatible with the development schedule, this time will be utilized. If this time period can not be tolerated every attempt should be made to allow a minimum of a 1-year storage period. The time duration should be established by the cognizant Tropic Test Center technical staff personnel.

(1) Storage configurations that will be used can be divided into two categories—open field storage and covered open-sided storage.

(a) Open field storage. The test item will be packed in its shipping and/or protective container and placed in an environmentally unprotected area. This area may be cleared or under jungle canopy depending on the type of climatic category desired. Test items will be placed on dunnage and covered (canvas, tarpaulin, etc.) or left uncovered.

(b) Covered open-sided storage. The test item will be packed in its shipping and/or protective container and placed in a shed consisting of a metal, plastic, or wooden cover with at least three open sides. The roof will protect the item from precipitation and falling debris. The storage shed may be located in a cleared area or under jungle canopy depending on the climatic category required.

(2) Meteorological conditions will be recorded at or near the storage site. This record can normally be taken from printouts of one of the permanent meteorological reporting stations. Temperature and relative humidity under the dunnage and/or within the protective container will be recorded if required by the Test Directive objectives.

(3) Test personnel will visually inspect the test items periodically and record in the test log all apparent effects of storage of the test item. Normal maintenance will be performed using the applicable Technical Manual.

(4) Personnel will photograph the storage site, test item storage configuration, and instrumentation array.

(5) At the completion of the storage phase, personnel will visually inspect and record any apparent degradation, photograph as required, and perform all required maintenance and operational checks to verify operation.

d. Tropic Performance. This performance subtest is separated into two areas of prime concern, i.e., transportation and handling, and functioning.

(1) Transportation and Handling Tests.

(a) Man-portable systems:

Remove the test items from storage and visually inspect them for any damage and/or degradation attributable to the environment.

Perform prescribed maintenance using the procedures outlined in the applicable Technical Manual. All maintenance will be performed by personnel with the MOS that would normally perform the maintenance in an operational situation.

Load the test items on tactical vehicles consistent with the normal mode of field transport for the item. The transport configuration will be consistent with that expected under actual combat conditions. Test items, in protective containers, will generally be placed in the cargo area unsecured.

Transport the test items over preselected courses consistent with vehicle capability; utilize MTP 2-4-003 (reference 10) for course selection. Total mileage for each cycle should be approximately 50 miles. NOTE: The vehicle-transport phase should be planned to terminate at or near the start of the man-pack portability course.

Remove the test items from the vehicles and perform visual and other required inspections, checkouts, alignments, etc. Any required maintenance will be accomplished using the procedures prescribed in the applicable Technical Manual.

Following vehicle transport, test items will be issued to a squad or similar combat unit. The squad will be equipped with standard TOE equipment normally issued to a unit in this geographical area.

If the test does not involve live firing of the test item, the squad will traverse the man-pack portability course as prescribed in TOP 1-3-550 (reference 9). A second squad will traverse the course carrying a control item, if available.

If the test item is to be fired, the squad will maneuver over a preselected course which will traverse hills, level terrain, jungle with heavy undergrowth, jungle (canopied), streams, and swamp (marsh) areas. The course should be approximately 2700 meters long and start and terminate near the selected firing range. For control purposes, a squad or similar combat unit will traverse the same course approximately one hour behind the squad equipped with the test items. The control unit will be equipped with the item that the test item is designed to replace.

A data recorder will accompany each squad and perform monitor and umpire duties. At the completion of portability testing, both squads will immediately begin the firing exercises.

Appropriate interviews will be conducted with each crew member, maintenance personnel, and test observer to determine proper or improper functioning of the test or central item, maintenance performed, problems encountered, the compatibility of the man and machine, and the subjective opinions of the ability of the equipment to support the mission and to determine whether or not the test item meets the principles of HFE.

Meteorological data will be recorded as appropriate.

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Photographic and video coverage will be made to show methods of carrying and deployment. Additional guidance is contained in MTP 10-3-506 (reference 15).

Physiological data will be recorded, if feasible, on all troops transversing the man-pack portability course to provide an assessment of the physical effort required to negotiate the course with the equipment being tested. If a test and control item are tested these data should be compared to allow an evaluation of competing systems.

(b) Mounted (vehicle) systems:

Remove the test item from storage and visually inspect it for any damage and/or degradation attributable to the environment.

Perform prescribed maintenance using the procedures outlined in the applicable Technical Manual. All maintenance will be performed by personnel with the MOS that would normally perform the maintenance in an operational situation. Interview all mechanics after maintenance operations are complete and record favorable or unfavorable opinions. Refer to paragraph f below.

Mount the test item on the tactical transporter in a manner consistent with normal modes for transport and secure for traveling.

Transport the test item over preselected courses (reference 15) consistent with transporter capabilities. Total mileage for each cycle should be approximately 100 miles. NOTE: Transport phase should terminate at the firing site.

After completing the transportation, perform visual and other required inspections, checkouts, alignments, etc. Any required maintenance will be accomplished using the procedures prescribed in the applicable Technical Manual.

(2) Functioning Tests.

(a) Man-portable systems:

Firings will be conducted under prevailing meteorological conditions using personnel who have completed the portability course.

The test officer will insure that a safety release has been received, and that all personnel are familiar with and adhere to the safety precautions.

Firings should include both stationary and moving targets at unknown ranges. An appropriate portion of firings should be conducted at night and/or during periods of reduced visibility. Any vision aids appropriate to either test or control items should be used.

Test personnel will fire in the various authorized firing positions consistent with the availability of test items, i.e., prone, sitting, kneeling, and standing.

The number of firings, mode of operation, sight(s) employed, and other live-fire requirements will be dictated by the commodity TOP, applicable Materiel Needs document and the Test Directive.

Record will be made of environmental conditions.

(b) Mounted (vehicle) systems. NOTE: Because of range limitations in the Canal Zone (4000 meters overland and 74,000 meters over water), it must be determined whether the firings will be accomplished at the Tropic Test Center or if the items will be returned to CONUS for firing.

All firings will be conducted under prevailing meteorological conditions.

The test officer will ensure that a safety release has been received, and that all personnel are familiar with and adhere to safety precautions.

The number of firings, mode of operation, sight(s) employed, and other live-fire requirements will be dictated by the commodity TOP, applicable Materiel Needs document and the Test Directive.

Photograph will be made of site, firings, and instrumentation.

e. Human Factors. This subtest should be conducted simultaneously with other appropriate subtests; however, it is a separate identifiable subtest and must be addressed separately in the test report. It must be designed in such a manner so as to assess the effectiveness of the man-item relationship and to determine whether the test item design and prescribed procedures for operability, maintainability, transportability, portability/usability and erectability conform to existing standards for HFE. Specific details for this subtest are contained in TECOM Supplement 1 to AR 602-1 (reference 2).

f. Maintenance will be performed in accordance with TECR 750-15 (reference 4).

(1) Required maintenance will be performed by personnel of the appropriate MOS. Maintenance will be accomplished using the procedures and tools specified in the manual.

(2) The adequacy of the maintenance instructions will be evaluated by observation and interview of the test participants. The following aspects will be evaluated and recorded:

(a) Adequacy of hoisting, lifting, and towing facilities

- (b) Ease of operations
- (c) Physical effort required for performance of duties
- (d) Adequacy of working space
- (e) Simplicity in servicing and performing maintenance duties
- (f) Effects of engine fumes on mechanics
- (g) Accessibility to components
- (h) Freedom of the mechanic to reach and work adequately as influenced by the configuration or placement of components, or by his clothing or size.
- (i) Servicing factors such as lubrication of equipment, replenishing tanks and reservoirs, and recharging gas bottles.

g. Safety.

- (1) Prepare safety SOP which includes:
 - (a) Safety procedures
 - (b) Safety precautions
 - (c) Protection equipment and location
 - (d) Emergency procedures
 - (e) Reference to applicable safety documents (e.g., safety releases, AMC safety regulations).
- (2) Inspect all test items for possible hazardous conditions—MTP 5-3-510 (reference 13).

5. Test Data

a. General. Prepare a test officer's logbook containing a list of critical or unusual test occurrences (in sequence), pertinent remarks and observations (not included on data sheets) concerning the test item or test procedures. The logbook will also include:

- (1) References to pertinent correspondence by file code and organization (e.g., 1309-11 DF, STETC-TD-A, USATTC, 12 Jul 73, subject: Meteorological Requirements).

- (2) Description of the test item and components
- (3) Photographic proof sheets of all applicable photographs
- (4) Notations of personnel, support, and range requests
- (5) Nomenclature, serial numbers, accuracy and calibration date of special instrumentation and test equipment
- (6) List of test personnel to include duty assignment, rank, brief background and training of each
- (7) Completed data sheets or reference to location
- (8) Charts, graphs, and other aids supplementing test findings
- b. Initial Inspection. Record the following:
 - (1) Date, location, and personnel
 - (2) Mode of shipment
 - (3) Condition and level of packaging
 - (4) Code numbers assigned and documentation of location, style, etc.
 - (5) Markings and labeling to include: Location, lot number, manufacturer and location, date of manufacture, and legibility and condition
 - (6) Any damage and/or defects and actions taken to correct them
 - (7) Physical characteristics to include: exterior dimensions (length, width, diameter, etc.), weights of test items and components, color and notation of any reflecting surfaces
 - (8) Inventory (packing list) of items and components; record of both missing and excess items
 - (9) Hour and/or mileage readings
 - (10) Adequacy of Technical Manual instructions used and note of any inadequacies
 - (11) Applicable photographs
- c. Initial Performance. Refer to paragraph e, below

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d. Tropic Storage. Record the following:

(1) Storage site description—vegetation, soil characteristics, terrain, grid location, and surrounding areas with photographs as appropriate (TOPS 1-1-008 and 1-1-051, reference 7 and 8)

(2) Storage configuration (including photographs) and test item orientation (upright, side, direction, etc.)

(3) Instrumentation (including photographs)—Nomenclature, accuracy, and calibration date

(4) Meteorological conditions—temperature, humidity, and precipitation.
NOTE: Meteorological data requirements are determined on a test-by-test basis. Normally the test officer and meteorologist will determine the need for obtaining any special meteorological requirements beyond those routinely collected at the established meteorological data sites.

(5) Date and time of periodic inspections, and personnel conducting inspection

(6) Inspection results, including:

(a) Any evidence of deterioration and/or damage

(b) Location of deterioration and/or damage

(c) Probable effects

(d) Corrective action (if any) taken, to include personnel, MOS, time and parts

(e) Appropriate photographs

(7) Maintenance data forms in accordance with TEAM-UP, Part D, Reliability and Maintainability Systems.

e. Tropic Performance.

(1) Transportation and handling. Record the following:

(a) Type vehicles used and mileage

(b) Vehicle speeds

(c) Course description (nomenclature, topographic and micro-relief maps or survey, vegetation description and classification, and soil description)

- (d) Test item code numbers
- (c) Personnel, including MOS and utilization during test
- (f) Transport configuration
- (g) Date and times
- (h) Meteorological conditions
- (i) Comments, interviews and/or questionnaire results
- (j) Maintenance data forms in accordance with TEAM UP Part D, Reliability and Maintainability System
- (k) Inspection results
- (l) Photographs
- (m) Type of instrumentation - Nomenclature, accuracy, and calibration date
- (2) Firing. Record the following:
 - (a) Date, time, and location
 - (b) Site description
 - (c) Test item code numbers
 - (d) Personnel, including MOS and utilization during test
 - (e) Firing and gunner's performance, to include range to target, target description (size, shape, azimuth, velocity, etc.), gunner's position, time to fire first round, first round hits, total hits, total misses and miss distance, malfunction correction time, gunner's estimate of range to target, hit coordinates, comments and observations
 - (f) Meteorological conditions
 - (g) Instrumentation, nomenclature, accuracy, and calibration date
 - (h) Maintenance data forms in accordance with TEAM-UP Part D, Reliability and Maintainability System
 - (i) Photographs
- f. Maintenance. The computer printouts prepared from the input provided by the maintenance data forms will provide all data required by TECR 750-15 for maintenance

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computations. In addition, record comments, interview and/or questionnaire results concerning the following maintenance aspects:

- (1) Ease of performing tasks
- (2) Special skills required
- (3) Special tools required
- (4) Adequacy of instruction
- (5) Simplicity of instructions
- (6) Photographs

g. Safety. Record the following:

- (1) Applicable portions of MTP 5-3-510
- (2) All safety discrepancies noted during test conduct, to include the method of correction or the reason for no correction

6. Analysis

a. Data—including observations, questionnaires, and comments of operators and handling personnel—obtained during test conduct will be summarized, compared, and evaluated.

b. Appropriate charts, graphs, and tables will be used to display summaries and comparisons of data. Coordinates and other features should be selected for clarity and uniformity with similar presentations in other reports. Special consideration in data presentation will be given to any environmental condition or circumstance which may have significantly influenced test results.

c. Qualitative data will be evaluated against the applicable Materiel Needs requirements to determine degree of achievement. In general, the Materiel Needs document will dictate the degree of detail necessary for preparing an analytical plan; therefore, this analysis section is general and further guidance must be obtained.

- (1) Initial Inspection.

- (a) Determine if the level of packaging is suitable for overseas shipment.

- (b) Determine if the items are in or have been restored to a suitable condition for testing.

(c) Subjectively determine if the instructions are adequate for proper testing.

(d) Compare the weights and dimensions of the test items and components with the physical characteristics criteria in the appropriate technical documents. If a confidence interval statement pertaining to weights and dimensions or to their variability is desired, computations can be made using one of the appropriate statistical routines in NBS Handbook 91 (reference 5).

(2) Initial Performance. Refer to paragraph d, below.

(3) Tropic Storage. After the storage phase, determine if the items are suitable for the performance test. If they are not, it must be stated that the test items are not suitable for use in a humid tropic environment. If the test items are determined satisfactory for performance testing, use the data collected from the initial performance and performance subtests to ascertain if any degradation in performance has resulted from the storage phase.

(4) Tropic Performance.

(a) Transportation and handling. A qualitative analysis should be made to determine if the test item can be transported and handled without degradation of the item and/or components.

(b) Firing. Reliability for proper functioning can be evaluated on a go no go basis using the cumulative form of the binomial distribution. For failed items, particular emphasis should be placed on proper determination of causes of failure (e.g., tropic environment).

(5) Maintenance. A subjective analysis will be made of the adequacy of the maintenance instructions and requirements for special tools and skills from comments of the test participants and interview and/or questionnaire results. Information for more detailed reporting, as set forth in the appropriate technical documents, can be obtained from TECR 750-15.

(6) Safety. Any safety problem areas will be analyzed carefully as to the cause and means of prevention. The adequacy of the safety instructions will be evaluated.

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: AMSTE-ME, Aberdeen Proving Ground, Maryland 21005. Technical information related to this publication may be obtained from the preparing activity, Commander, US Army Tropic Test Center, ATTN: STETC-TD-T, Fort Clayton, Canal Zone. Additional copies of this document are available from the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314. This document is identified by the accession number (AD No.) stamped on the first page.

APPENDIX
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